CUSHENBURY BUCKWHEAT
Eriogonum ovalifolium Nutt. var. *vineum* (Stokes) Jepson

Author: Andrew C. Sanders, Herbarium, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124

Management Status: Federal: Endangered
California: S1.1, G5T1 (CDFG, 1998)
CNPS: List 1B, RED code 3-3-3 (Skinner and Pavlik, 1994)

General Distribution:

Cushenbury buckwheat is endemic to California and is restricted to dry calcareous (primarily limestone) slopes of the northern San Bernardino Mountains (Reveal, 1993). Most populations are on lands within the boundary of the San Bernardino National Forest, but the taxon does extend slightly onto BLM and private lands along the southern edge of the WMPA. The overall range of this plant extends from White Mountain southeast to Mineral Mountain on the north side of Rattlesnake Canyon.

There is a recent report of what is possibly this plant from the southern Sierra Nevada Mountains, but the identification has not yet been confirmed. This discovery is discussed in greater detail in the Natural History section, below.

Distribution in the West Mojave Planning Area:

This species seems to barely extend into the WMPA in a narrow band from North Peak in the west to Round Mountain and the Partin Bros. Mine, east of Cushenbury Canyon. The distribution in the WMPA is restricted to scattered populations at the north foot of the San Bernardino Mountains along the southern margin of the WMPA, adjacent to the San Bernardino National Forest. Specific localities include: Arctic Canyon, 5200-5400 ft. (1585-1645 m), T.3N R.1E Sec 16; NE of Monarch Flat, 4800 ft. (1450 m), T.1E R.3N Sec 12; 1/8 mi. (0.2 km) north of North Peak, T.3N R.1W Sec 6; and Cushenbury Canyon.

Natural History:

Cushenbury buckwheat (Polygonaceae) was originally described as a distinct species, *Eriogonum vineum*, by Small (1898) from plants collected near Rose Mine by S.B. Parish (#3170) in 1894. At that time Small confused it with plants from farther north and cited a specimen from Oregon as representing this taxon also. It is now believed that this plant is endemic to the San Bernardino Mountains, with the possible exception of a small population in the southern Sierra Nevada.

Cushenbury buckwheat is a long-lived prostrate to mound-forming shrub that typically occurs on rocky slopes, often in cracks on bedrock or on otherwise stable slopes, but is also known from deeper soils derived from decomposed carbonates. It is typically not found in disturbed areas (either naturally or by man), nor is it usually found along washes or on canyon bottoms, unlike Parish's daisy (*Erigeron parishii)*, another limestone endemic that often occurs nearby. But, it has occasionally been found colonizing abandoned haul roads, as at Furnace Canyon (pers. obs., 1998). It is the only variety of *Eriogonum ovalifolium* found in the San

Bernardino Mountains, though other varieties occur elsewhere on similar substrates. It has never been found away from carbonate substrates and appears to be more common on the higher value limestones than it is on the economically unimportant dolomites. It is thus, based on information from a survey done for a consortium of mining companies in 1992 (Tierra Madre, 1992), particularly vulnerable to destruction by limestone mining (Sanders, 1992).

Cushenbury buckwheat plants are very compact with short woody stems spreading a few centimeters over the ground. They have been described as "forming large silver mats" resembling "boulders of the limestone it occurs on" (T. Krantz, label notes, UCR). The foliage mounds seldom rise more than 4 in. (10 cm) above the surrounding rocks or soil. However, when the plants begin flowering, they send up inflorescences 1-5 in. (2-12 cm) above the foliage. The several to many short woody stems spread and ascend over a very small patch of ground from a thick woody base above a deep and well-developed woody taproot. The short branches hold many small round-obovate leaves with blades 0.16-0.5 in. (4-12 mm) long and slightly narrower. The petioles are distinct and ca. 0.12-0.24 in. (3-6 mm) long. The foliage is densely covered with tangled, white, rather felty, hairs on both surfaces. The leaves densely cover the upper parts of the stems and are densely grouped so that the ground is generally not visible through the plant. This overall plant density is partly caused by the dried leaves which do not fall from the plant but simply turn a dark brown color and cling to the older parts of the stem. This presumably provides insulation for the plant as well as added protection from water loss through the stems.

Cushenbury buckwheat seems to share many general ecological characteristics with the other varieties of *E. ovalifolium*. It is a perennial of open areas and appears intolerant of extensive shading, preferring full sunlight, and typically occurs between shrubs rather than under them (White, 1997). *Eriogonum ovalifolium* is not a species well adapted to competing for light, but it is very competitive on sites where tall and fast growing species are excluded by moisture deficiencies, wind, winter cold, or nutrient deficiencies. The compact "cushion" habit probably serves to reduce moisture loss on windy ridges as is true for other species of similar life form (Walter, 1973). The short annual growth intervals and consequent low stature makes all races of *E. ovalifolium* poor competitors on sites that are capable of supporting tall or dense vegetation. However, sites where moisture stress is combined with high insolation are highly favorable for plants such as this one. The nutrient deficiencies of limestone soil, exacerbated by the high pH which interferes with mineral uptake, doubtless serve to further reduce competition by fast growing species.

Winter cold is another major ecological factor that affects interior and montane species in the temperate zone. Cushenbury buckwheat, and other low growing cushion species, may be regularly covered by snow during the period of the year when soil moisture is unavailable because the ground is frozen, and when, in arid areas, the humidity of the air may still be very low. When covered with snow, Cushenbury buckwheat is subjected to even less moisture stress than it would be if exposed to the dry air. Under snow, the relative humidity is at virtually 100% and wind effects are excluded. Even when exposed, the low dense form of the plant shelters much of it from direct wind effects. The dense covering of wool on the leaves is evidence that moisture and not light is a major controlling factor for this species. Such a woolly covering will greatly reduce the amount of light striking the chloroplasts in the leaf tissue, but this tomentum also forms a layer of dead air at the leaf surface and may reduce water loss due to wind.

The inflorescence consists of a leafless peduncle (flowering stem) that supports a group of involucres that form a single head-like unbel of cream-white to reddish flowers, with green to reddish midribs, at the tip. The flowers are perfect (possess both male and female parts). Cushenbury buckwheat is distinguished from other mat-forming buckwheats in the San Bernardino Mountains by its compact cushion-form habit, large solitary heads of cream-white to maroon flowers, and round-obovate leaves. There are two similar buckwheat species in the general region. Perhaps the most grossly similar species in the area is southern mountain buckwheat (*Eriogonum kennedyi* var. *austromontanum)*, which occurs in a different habitat (pebble plains) and which has narrower leaves and smaller heads. Its general lifeform is very similar to Cushenbury buckwheat. Skree buckwheat (*Eriogonum saxatile*) is also quite similar, and occurs in the same general areas, but has a more open form and occurs primarily on loose granitic soils on slides and along washes. It is also less long-lived and is seldom conspicuously woody. Its leaf morphology is very similar, but its open cymose inflorescence is quite different from the compact head of Cushenbury buckwheat.

Based on a relatively small sample of herbarium specimens, it appears that Cushenbury buckwheat fruits ripen primarily in about July following the main May-June flowering period, but must ripen later for later flowerings (see below). This would make the seeds ready for germination at the time of any summer rains in August/September, assuming the seeds do not remain dormant for a lengthy period following dispersal. It appears that the relatively large perianth may dry around the fruit, with the achenes remaining attached to the receptacle, and that this whole unit is involved in dispersal, with the dried tepals acting as wings. Wind is thus probably important for local dispersal. Wind is not, however, very effective over long distances. Seed dispersal has not been studied in this species (or variety), but Stokes (1936) thought that birds may play a role in the dispersal of all *Eriogonum* seeds based on various observations of birds and their behaviors. She thought that seeds stored in the crop of a bird killed by a predator might serve to establish new populations in areas distant from existing populations. She also mentioned wind, rain and streams as dispersal agents, but presented no data to support these ideas. Given the extremely restricted distribution of Cushenbury buckwheat, it is not clear that long-distance dispersal has ever occurred and it certainly does not appear to be a common phenomenon. The rest of the varieties of *E. ovalifolium* occur north of the Mojave Desert, such as in the Inyo-White Mtns. and Sierra Nevada (Reveal, 1968) as well as through the Great Basin (e.g., Kartesz, 1988; Welsh et al, 1987; Reveal, 1968). It thus does appear that long distance dispersal occurred at some point, unless there was formerly suitable habitat across the Mojave Desert. There are scattered limestone outcrops on the Mojave Desert that would have supported pinyon woodland when, during the Pleistocene, this more mesic vegetation occupied what are now desert flats (Raven and Axelrod, 1978). These limestone hills could perhaps have served as stepping stones across the desert for populations of *Eriogonum ovalifolium*. It should also be noted that *Eriogonum ovalifolium* in general is not restricted to limestone. Other varieties of the species commonly occur on granite or general alluvium in sagebrush scrub (Reveal, 1968; Welsh et al., 1987). Thus it is possible that this taxon entered the range on other substrates, but then became restricted to limestone by competitive exclusion and subsequent refinement of existing adaptations.

The flowers are relatively large and are clustered into conspicuous head-like umbels. The flowers fade to pink or red at maturity (i.e., probably after pollination) and primarily bloom in May and June. There can be later flowering, for example in September (e.g., Derby and Krantz, s.n., UCR), but the extent of such late flowering or its environmental triggers are unknown. The flowers often dry to a yellowish color in herbarium specimens, but whether this may reflect the original color of some populations is unknown and unlikely. Few collectors of this species appear to bother recording flower color. White (#4012, UCR) has recorded the color of young flowers as "dull white w/reddish vein at centers of "petals" and reddish anthers". Maile Neel (pers. comm.) reports that there is flower color variation within populations and that fresh flowers vary from creamy white to yellowish and that some are pinkish to maroon even when newly opened. She also reports that not all individuals have flowers that turn reddish in age. Clearly, there is need for further study of the trends in flower color in this plant.

Pollination of this plant has only recently been studied, and small insects are almost certainly its pollinators (S. Morita, pers. comm., 1998). The flower color changes to red suggest that the pollinator may be a bee, but such have rarely been observed on the species and Morita (pers. comm., 1998) thinks the pollinators may be generalist flower visitors, rather than a specialist such as a bee. In the summer of 1998 Morita observed nearly 100 insect species visiting this plant, including potential pollinators, plant feeders and others. She noted that because it is relatively late flowering, it is one of the few nectar sources available in its habitat at the time it flowers and so may be heavily visited for that reason. The generalists that are potentially pollinators included many flies, particularly tachinids and bee-flies (Bombylidae), but also many smaller species, such as chloropids. A small species of bee-fly was locally common on the flowers. Two species of small solitary bees (Andrenidae and Halictidae) were also seen visiting, but these were very few (Morita, pers. comm., 1998). Exactly which species serve as effective pollinators has not yet been determined.

Among the plant feeders present were a leaf beetle (Chrysomelidae) which was seen eating the flowers, soft-winged flower beetles (Dasytidae) which were present in the flowers, and various hemipterans, including the small milkweed bug (*Lygaeus*), various plant bugs (Miridae), and stink bugs (Pentatomidae). Grasshoppers (Acrididae) and their nymphs were also present and probably feed on the foliage of the Cushenbury buckwheat.

Habitat Requirements:

This taxon is apparently restricted to carbonate slopes on the north side of the San Bernardino Mountains. As noted above, it seems to display a preference for limestone rather than dolomite, but this needs confirmation. It also seems to prefer stable slopes with bedrock outcropping, and is rarely found on unstable slopes or along active washes. It can be locally common where it is found, but more commonly is present as scattered individuals. Cushenbury buckwheat occurs primarily in pinyon-juniper woodland but also descends into Joshua tree woodland, mixed desert and blackbrush scrub and extends upward into Jeffrey pine-western juniper woodland (Munz, 1974; Skinner and Pavlik, 1994; Gonella and Neel, 1995). Among its typical associates are: single-needled pinyon (*Pinus monophylla*), big-berried manzanita (*Arctostaphylos glauca*), curl-leaf mountain-mahogany (*Cercocarpus ledifolius*), Shockley's rock cress (*Arabis shockleyi)*, rose sage (*Salvia pachyphylla*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*C. nauseosus*), big sagebrush (*Artemisia tridentata*), pine needlegrass (*Stipa pinetorum*), canyon live-oak (*Quercus chrysolepis*), nevada forsellesia (*Forsellesia nevadensis*), green Mormon tea (*Ephedra viridis*), blackbrush (*Coleogyne ramosissima*), Coville's dwarf abronia (*Abronia nana covillei*), yellow cryptantha (*Cryptantha confertiflora*), Utah juniper (*Juniperus osteosperma*), small-cup buckwheat (*Eriogonum microthecum*), and Parish's daisy (*Erigeron parishii*).

Based on specimens at UCR, populations occur at elevations between 4800 and 6500 ft. (1450 and 1982 m), though Munz (1974) reports "ca. 5000-5500 ft." (1500-1675 m) and Reveal (1993) reports 1500-2100 m (5000-7000 ft.). Recent plot-based sampling has found it between 4680 and 7840 ft. (M. Neel, pers. comm.), and Melody Lardner (pers. comm.) reports that the Forest Service has the species mapped up to 8100 ft. elevation.

Dana York, a biologist with CalTrans, has collected plants in the Kings River Canyon near Boyden Cave, Fresno County, that Steve Boyd believes are Cushenbury buckwheat (Boyd, pers. comm., 1997). The plants form mats on N-facing carbonate (marble) slopes at 6,000 ft. elevation (York, pers. comm., 1998), which is a habitat very similar to that of *E. ovalifolium* var. *vineum*. York has received different identifications of these plants from virtually everyone he's sent them to, including a determination of *E. o.* var. *nivale* by James Reveal, the foremost expert on *Eriogonum.* York is convinced, however, that the plants are not *E. o.* var. *nivale* because their morphology and habitat are quite different. He has not yet decided exactly what they are, though seems to feel that *E. o. vineum* is a strong possibility (York, pers. comm., 1998). Whatever the ultimate determination about the identity of the Boyden Cave plants, the taxon will still be very rare as the Fresno County population consists of only about 30 plants at one site.

Population Status:

Cushenbury buckwheat is naturally very restricted in its distribution, but has additionally suffered a large but unquantified population decline due to limestone mining (Krantz, 1988; Gonella and Neel, 1995). There are no populations that are secure from mining activity and most are within areas subject to massive disturbance within the next few decades.

Populations of this long-lived plant appear stable in areas where they are undisturbed (pers. obs.), but its habitat has been heavily disturbed and many plants destroyed by mines, haul roads, waste dumps and other mining related activities in recent decades (Krantz, 1988).

Threats Analysis:

The major and only significant threat to this species is the mining of limestone along the north face of the San Bernardino Mountains. It is estimated that over 1600 acres of potential habitat for the various carbonate endemics has been lost to mining (Gonella and Neel, 1995). Because of the steep rocky slopes it occupies, off highway vehicles and urbanization are not significant threats. Likewise, cattle grazing has never been a significant activity in the areas this species occupies. The topography combined with the arid and highly seasonal climate, makes the habitat of Cushenbury buckwheat unsuitable for all these activities. The profitability of limestone mining has made feasible destructive activities on a scale that dwarfs the problems that threaten rare species in other habitats.

Because of their difficult nutrient regime (e.g., Gonella and Neel, 1995), the carbonate slopes are not heavily invaded by alien weeds (pers. obs.), most of which depend on high levels of nitrogen and other nutrients. There are certainly places where weeds are common, but overall it appears that the weed problem is much less severe than it is on granitic soils on the coastal slope of the mountains. It appears that native plant densities on limestone have not generally been adversely affected by weed invasion, as they have been in some other areas.

There has historically been rather weak conservation planning for this species by the relevant agencies (Krantz, 1988), and the mining companies have not taken any proactive steps to assure the continued existence of this plant. In the past 10 years or so, the U.S. Forest Service has been actively trying to design an adequate reserve program, but so far nothing has been formally established. As a result, there has been a continuous incremental loss of both habitat and population by this taxon.

Biological Standards:

The most important issue in the protection of this species is clearly the need for the establishment of a series of reserves protected from limestone mining that support adequately large (and that still needs definition) populations of this species, over a range of the environmental conditions it occupies. There appear to be no populations that are currently in protected status of any sort. Many populations are on public lands, but these are almost all under claim for limestone mining by one company or another (USFWS, 1997). Any reserve design must take into account the need for populations to adjust geographically (shift) in response to long-term climatic change. Reserves must thus include a range of elevations and adequate linkage between zones.

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